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(71) Applicant: **Black & Decker Inc.**
Newark Delaware 19711 (US)

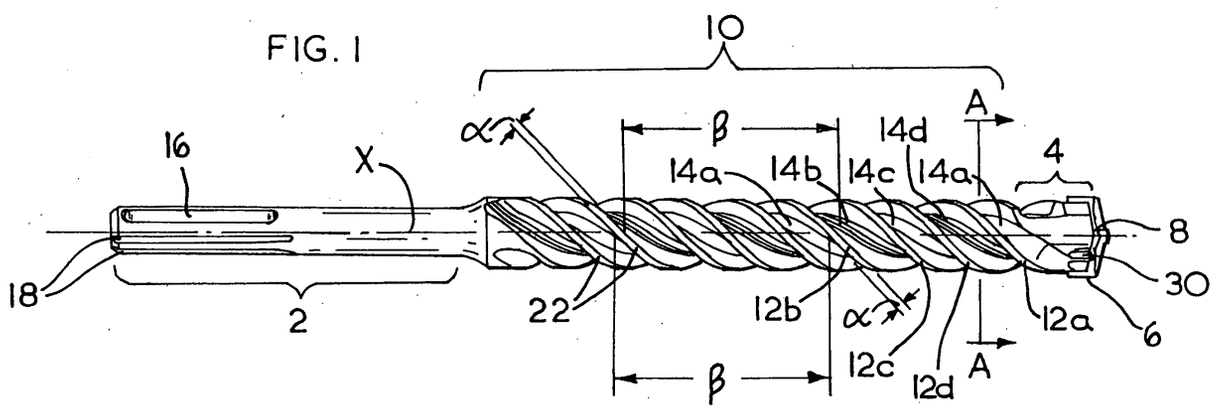
(72) Inventor: **Meierhofer, Markus**
94032 Passau (DE)

(74) Representative: **Bell, Ian Stephen et al**
Black & Decker,
210 Bath Road
Slough, Berks SL1 3YD (GB)

(54) Masonry drilling tool

(57) A masonry or rock drilling tool suitable for use with a rotary hammer comprising a drilling head (4, 104) at a forward end of the tool within which a forwardly extending cutting plate (6, 106) is fitted or formed and on the circumferential periphery of which is formed first and second opposing axially extending channels (36, 38, 136, 138). The tool has a clamping shank (2, 102) at a rearward end of the tool suitable for fitment within a tool holder of a rotary hammer and an intermediate helical conveying portion (10, 110) extending between the drilling head and the clamping shank. The intermediate helical conveying portion comprises at least four helically extending flutes (14a-d, 114a-d) separated by corresponding helically extending webs (12a-d, 112a-d). The first of the axially extending channel extends axially rearwardly from a forward facing face of the drilling head into two of the four flutes and the second of the axially extending channel extends axially rearwardly from the forward facing face of the drilling head into the other two of the four flutes. By having each axially extending channel leading into two of the four flutes the conveying properties of the tool are substantially enhanced.

FIG. 1



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Description

[0001] This invention relates to a drilling tool for a rotary hammer, in particular to a masonry or rock drilling tool.

[0002] Masonry drilling tools generally comprise a drill head provided with a carbide cutting plate, and optionally side cutting plates and a single-start or multi-start spiral conveying helix, which adjoins the drill head. At the end of the conveying helix remote from the drill head is generally provided a clamping shank which can be releasably fixed within a tool holder of a rotary hammer. Such masonry drilling tools are generally driven by a rotary hammer which can simultaneously apply a rotational drive to the drilling tool and repeated axial impacts to the rearward end of the drilling tool.

[0003] In masonry drilling tools, the primary function of the conveying helix is to convey out of the drilled hole material, such as dust and chippings, broken away by the carbide cutting plate. It is important to the performance of the drilling tool that a large volume of broken material, such as dust and chippings, is conveyed out of the drilled hole because this aids the advancement of the drilling tool into the drilled hole. Good material conveying properties also help to prevent jamming of the drilling tool within the drilled hole, which jamming can damage the drilling tool and the rotary hammer driving the drilling tool. The life of the drilling tool is also improved if it has good material conveying properties. The conveying helix also performs, the function of guiding the drilling tool within the drilled hole.

[0004] The conveying helix generally comprises one or more discharge grooves or flutes which extend helically around the drilling tool. Each of the flutes is bounded on each side by a corresponding helically extending web. Each web has a conveying surface which faces in the direction of the clamping shank of the tool along which broken material is conveyed. The radially outwardly facing surface of the webs guides the drilling tool within the drilled hole.

[0005] There are a number of proposals for improving the conveying properties of the conveying helix, for example WO99/29998, which advocates the use of auxiliary webs and/or flutes in addition to the primary webs and flutes of a drilling tool.

[0006] Critical to the conveyance of broken material out of the drilled hole is the conveyance of broken material from the carbide cutting plate at the forward facing face of the drill head, where the broken material is generated to the entrances to the flutes of the conveying helices. For this purpose a plurality of substantially axially extending channels are generally formed around the drill head for transporting broken material from the cutting plate or plates to the entrances to the flutes of the conveying helices. This has been addressed, for example in EP657,617 and DE197 03 994 in which relatively high volume channels are provided for this purpose. Also, DE195 37 900 and DE200 21 710 propose improved designs of such channels.

[0007] The present invention aims to provide an improved design of drilling tool which provides significant improvements to the cutting performance of the drilling tool and the conveyance of broken material from the forward end of the drilling head to the forward entrances to the flutes of the conveying helices.

[0008] According to a first aspect of the present invention there is provided a masonry or rock drilling tool suitable for use with a rotary hammer comprising:

a drilling head at a forward end of the tool within which a forwardly extending cutting plate is fitted or formed and on the circumferential periphery of which drilling head are formed first and second opposing axially extending channels;

a clamping shank at a rearward end of the tool suitable for fitment within a tool holder of a rotary hammer; and

an intermediate helical conveying portion extending between the drilling head and the clamping shank and comprising at least four helically extending flutes separated by corresponding helically extending webs;

characterised in that the tool additionally comprises the features that:

the cutting plate is formed with a central chiselling dome and a pair of cutting edges extending radially outwardly from the chiselling dome, wherein each cutting edge has a trailing relief face and the acute angle between the relief face and the longitudinal axis of the tool varies from the radially inner to the radially outer end of each cutting edge, for example by increasing from the radially inner to the radially outer portion of the cutting edge; and

the first axially extending channel extends axially rearwardly from a forward facing face of the drilling head into a plurality of the at least four flutes and the second axially extending channel extends axially rearwardly from the forward facing face of the drilling head into a different plurality of the at least four flutes.

[0009] By using a cutting plate of the type defined in the characterising portion of the claim the cutting action of the tool generates a high volume of broken material. By ensuring that each of the axially extending channels, which extend rearwardly from the forwardly facing face of the drill head, feed into more than one of the flutes of the helical conveying portion of the tool, the broken material conveying properties of the tool are sufficient to remove the broken material generated by the cutting plate. Accordingly, the configuration of the channels supports the cutting action of the cutting plate. The in-

terface between the axially extending channels and the flutes maintains a relatively high volume through which broken material can be transported. The webs which separate the flutes into which each channel extends facilitates the conveyance of broken material rearwardly from the channels. In order to facilitate this transportation of broken material by the rearwardly facing conveying surfaces of the webs, the webs that separate the pluralities of flutes into which each channel extends may terminate in a location circumferentially central of the associated axially extending channel.

[0010] There may be four flutes and four webs formed on the helical conveying portion of the drilling tool arranged so that the first axially extending channel extends into two of the four flutes and the second axially extending channel extends into the remaining two of the four flutes. In this case the conveyance of broken material can be improved if the webs that separate the pairs of flutes into which each channel extends terminate in a location circumferentially central of the associated axially extending channel.

[0011] The cutting plate may be formed of a carbide material and may extend transversely across the drilling head with the first channel formed to a first side of the cutting plate and the second channel formed to a second opposite side of the cutting plate. Each cutting edge may form a boundary between a respective cutting face (43,143) and a respective trailing relief face (46,146) of the cutting plate. The acute angle between the cutting face and the longitudinal axis of the tool may vary along the cutting edge, for example by increasing from the radially inner to the radially outer portion of the cutting edge. The dome may be elliptical with the major axis of the elipse extending substantially parallel to the cutting edges of the cutting plate.

[0012] In order to provide sufficient volume for the transportation of broken material while maintaining the strength of the drill head, both axially extending channels may together extend over between 34% and 70% of the circumferential surface of the drilling head. For larger diameter tools, for example over around 16mm diameter tools, this range is preferably between 40% and 60%. Also, the axially extending channels may have bases with a diameter of between 40% and 85% of the diameter of the drilling head. For larger diameter tools, for example over around 16mm diameter tools, this range is preferably between 40% and 60%.

[0013] The surfaces of the channels may be formed so that they extend substantially parallel to the longitudinal axis of the tool. In order to provide sufficient volume for the transportation of broken material while maintaining the strength of the drilling head the channels may be concave.

[0014] To improve the cutting performance of the drilling head auxiliary cutters, for example of a carbide material, may be fitted or formed at the forward end of the drilling head. For example; an auxiliary cutter may trail each cutting edge of the cutting plate in the direction of rotation. In this case, additional broken material can be transported rearwardly if an additional auxiliary axially extending channel is formed on the circumferential periphery of the drill head between each auxiliary cutter and the cutting edge of the cutting plate trailed by said auxiliary cutter so that each auxiliary channel extends axially from the forward facing face of the drill head into at least one of the at least four flutes.

[0015] The webs may all have the same diameter, in which case each of the webs may be formed with a radially outwardly facing surface for guiding the drilling tool within a drilled hole. Alternatively, the webs may include at least two primary webs and at least two auxiliary webs of reduced diameter compared to the primary webs, in which case the primary webs may each be formed with a radially outwardly facing surface for guiding the drilling tool within a drilled hole. The secondary webs may come to a point at their radially outer ends. Where there are auxiliary webs, better broken material conveying properties is achieved where the webs that separate the pluralities of flutes into which each channel extends and which terminate in a location circumferentially central of the associated axially extending channel are auxiliary webs. The webs have rearwardly facing broken material conveying surfaces and the webs, including the aforementioned primary or auxiliary webs, may have conveying surfaces which extend substantially perpendicularly to the longitudinal axis of the tool.

[0016] According to a second aspect of the present invention there is provided a masonry or rock drilling tool suitable for use with a rotary hammer comprising:

a drilling head at a forward end of the tool within which a forwardly extending cutting plate is fitted or formed and on the circumferential periphery of which is formed first and second opposing axially extending channels;

a clamping shank at a rearward end of the tool suitable for fitment within a tool holder of a rotary hammer;

an intermediate helical conveying portion extending between the drilling head and the clamping shank and comprising at least four helically extending flutes separated by corresponding helically extending webs;

characterised in that the first axially extending channel is concave and extends axially rearwardly from a forward facing face of the drilling head into a plurality of the at least four flutes and the second axially extending channel is concave and extends axially rearwardly from the forward facing face of the drilling head into a different plurality of the at least four flutes.

[0017] By ensuring that the axially extending channels, which extend rearwardly from the forwardly facing face of the drill head are concave and each feed into

more than one of the flutes of the helical conveying portion of the tool, the broken material conveying properties of the tool are significantly enhanced. Making the channels concave provides sufficient volume for the transportation of broken material while maintaining the strength of the drilling head.

[0018] The second aspect of the present invention may include the same auxiliary features as described above in relation to the first aspect of the present invention. In particular a drilling tool according to the second aspect of the present invention may include the design of cutting plate described above in relation to the first aspect of the present invention.

[0019] Embodiments of a tool according to the present invention will now be described by way of example, with reference to the accompanying drawings in which:

Figure 1 shows a perspective view of a drilling tool according to a first embodiment of the present invention;
Figure 2 shows a view of the forward end of the drilling tool of Figure 1;
Figure 3 shows a transverse cross-section through section A-A of Figure 1;
Figure 4 shows a longitudinal cross-section through the helical conveying portion of the drilling tool of Figure 1;
Figure 5 shows a first perspective view of the drilling head of the drilling tool of Figure 1;
Figure 6 shows a second perspective view of the drilling head of the drilling tool of Figure 1;
Figure 7 shows a perspective view of a drilling tool according to a second embodiment of the present invention;
Figure 8 shows a longitudinal cross-section through the helical conveying portion of the drilling tool of Figure 7;
Figure 9 shows a transverse cross-section through section A-A of Figure 7;
Figure 10 shows a view of the forward end of the drilling tool of Figure 7;
Figure 11 shows a first perspective view of the drilling head of the drilling tool of Figure 7; and
Figure 12 shows a second perspective view of the drilling head of the drilling tool of Figure 7.

[0020] Figures 1 to 6 show a first design of drilling tool according to the present invention. This form of drilling tool is especially suitable for tools having diameters of between 16mm and 40mm. The tool has a clamping shank portion (2) at its rearward end which can be releasably fitted within a tool holder of a rotary hammer. The tool has a drilling head (4) at its forward end within which are mounted a primary carbide cutting plate (6) and a pair of auxiliary carbide cutting tips (30). The tool has an intermediate helical conveying portion (10) extending between the clamping shank portion (2) and the drilling head (4) around which extend four helical webs (12a-d) and corresponding helical flutes (14a-d). The drilling tool of Figure 1 has a nominal diameter of 30mm.

[0021] The clamping shank of the tool shown in Figure 1 is configured as an SDS-Max clamping shank, as is well known in the art. The shank comprises a pair of opposing axially closed grooves (16) within which locking elements of a tool holder of a rotary hammer are generally received so as to enable limited reciprocation of the drilling tool with respect to the tool holder. In addition the shank is formed with three axially extending slots (18) which are each open at their rearward end which terminates at the rearward end of the shank portion (2). Two of the three open slots (18) are shown in Figure 1, the third slot is not shown but is formed on the opposite side of the shank portion (2) to the two slots shown. When the drilling tool is fitted within a tool holder of a rotary hammer corresponding splines formed on the tool holder engage in the open slots (18) to transmit rotary drive from the tool holder to the drilling tool.

[0022] The conveying helical portion (10) of the drilling tool comprises four discharge grooves or flutes (14a-d) which extend helically around the drilling tool with a pitch β of 80mm per rotation. Each of the flutes (14a-d) is bounded on each side by a corresponding helically extending web (12a-d). Each web has a conveying surface (20) which faces in the direction of the clamping shank of the tool and extend in a direction substantially perpendicular to the longitudinal axis of the drilling tool, along which broken material is conveyed. The radially outwardly facing surface (22) of the webs guide the drilling tool within the drilled hole. The diameter of the webs is 27mm and the diameter of the bases of the flutes is 15.5mm. Opposing flutes (14a and c) together extend over 36% and opposing flutes (14b and d) together extend circumferentially over 45% of the outer circumference (24) of the helical conveying portion of the drilling tool. The radially outer surface (22) of each web extends over 4.75% of the outer circumference (24) of the helical conveying portion of the frilling tool, which corresponds to a web width α of 4.06mm.

[0023] The drilling head is best understood from Figures 2, 5 and 6 and is formed with a transverse slot within which is fixed, for example by braising a carbide cutting plate (6). The drilling head has a diameter D of 27mm. The cutting plate (6) extends axially beyond the forward facing face (8) of the drilling head and radially beyond both ends of the transverse slot in the drilling head to a diameter of 30.46mm.

[0024] The two portions of the drilling head trailing the cutting plate (6) in the direction of rotation (R) are each formed with a secondary axially extending channel (26a, 26c). The secondary channels (26a, 26c) extend from the forward face (8) of the drilling head to an entrance of a respective flute (14a, 14c), as can be seen in Figures 5 and 6. The base of each secondary channel (26a, 26c) has a diameter δ of 23mm and each secondary channel extends circumferentially over 6.5% of the cir-

cumference (28) of the drilling head.

[0025] The two portions of the drilling head trailing the secondary channels (26a, 26c) in the direction of rotation are formed with substantially radially extending slots open at their radially outer end and closed at their radially inner end, within each of which is fitted, for example by braising, an auxiliary cutting tip or plate (30). The auxiliary cutting plates (30) extend radially outwardly to the same diameter as the cutting plate (6) and are axially recessed with respect to the cutting plate (6). Each auxiliary cutting plate (30) trails the cutting plate (6) in the direction of rotation (R) by an angle ε of 56°. Each auxiliary plate (30) has a cutting edge (32) and a trailing flank portion (34).

[0026] The two portions of the drilling head trailing the auxiliary plates (30) in the direction of rotation (R) are each formed with concave primary axially extending channels (36, 38). The first primary channel (36) extends from the forward facing face (8) of the drilling head to the entrance to two of the four flutes (14a, 14b) and the second primary channel (38) extends from the forward facing face of the drilling head to the entrance to the remaining two of the four flutes (14c, 14d). Each channel (36, 38) extends over 22.75% of the circumference (28) of the drilling head. This means that both channels together extend over 45.5% of the circumference (28) of the drilling head, but this percentage may be varied within the range of 40% to 60%. The diameter of the base of each channel is 13.58mm, which is approximately 50% of the diameter of the drilling head, but this percentage may be varied within the range of 40% to 60%. Accordingly, each primary channels (36, 38) is of sufficient volume to efficiently convey broken material from the forward face (8) of the drilling head to the entrances to two of the four flutes of the drilling tool. The concave shape of the channels (36, 38) provides a high volume for broken material removal while maintaining the strength of the drilling head. This arrangement, whereby each primary channel (36, 38) conveys broken material into two flutes, greatly improves the conveying of broken material from the forward face (8) of the drilling head to the conveying flutes (14a-d) and significantly reduces the incidence of blockages and improves the ease with which the drilling tool advances into a drilled hole. The channels (36, 38) have radially outwardly facing surfaces which are parallel to the longitudinal axis (X) of the drilling tool. The circumferential positioning of the channels (36, 38) on the drilling head is selected so that each channel, as it extends axially rearwardly intersects of two of the flutes (14a-d) and so extends smoothly into two of the flutes (14a-14d). The arrows in Figures 5 and 6 show the transportation of broken material from the primary channel (36) into the flutes (14a) and (14b).

[0027] The web (12b) lies between the two flutes (14a and b) into which the channel (36) extends. The web (12b) terminates in a circumferentially central portion of the rearward end of the channel (36). Thus, the web (12b) provides a broken material conveying surface which communicates with the central portion of the channel (36) so as to convey broken material rearwardly out of the channel. Similarly, the web (12b) separates the flutes (14c and d) into which the channel (38) extends, which web (12d) terminates in a circumferentially central portion of the rearward end of the channel (38).

[0028] The chiselling surface of the cutting plate (6) is formed by a central dome (50) formed as a smooth elliptical projection which is positioned to coincide with the longitudinal axis of the (X) of the tool. A cutting edge (44) extends radially outwardly from the dome (50) along the two halves of the cutting plate (6). In each half of the cutting plate, the cutting edge (44) defines a boundary between a cutting face (43) and a trailing relief face (46). The cutting face (43) slopes axially rearwardly from the cutting edge (44) in a direction extending from the cutting edge (44) in the direction of rotation (R) at a first angle ϕ to the longitudinal axis (X) of the drilling tool. The relief face (46) slopes axially rearwardly in a direction extending from the cutting edge (44) opposite to the direction of rotation (R) at a second angle θ to the longitudinal axis of the drilling tool. The first angle ϕ is smaller than the second angle θ. Moving outwardly from the central dome (50) the angles ϕ and θ of the cutting face (43) and relief face (46) increase with respect to the longitudinal axis of the drilling tool from the central region (adjacent the dome (50)) to the radially peripheral region of the cutting plate. This can be seen in Figure 5. The increase in the angle θ is continuous along the cutting edge (44), as is the increase in the angle ϕ.

[0029] This design of cutting plate generates high volumes of broken material per unit time and the channels (36, 38) with each cannel feeding broken material into two flutes enables this broken material to be efficiently removed from the region of the cutting plate. Therefore, the performance of the cutting plate (6) is not unduly prejudiced by the presence of broken material.

[0030] Figures 7 to 12 show a second design of drilling tool according to the present invention. The second design of drilling tool is more suitable for drilling tools having smaller drilling diameters, for example in the range of 3.4mm to 16mm. The tool has a clamping shank portion (102) at its rearward end which can be releasably fitted within a tool holder of a rotary hammer. The tool has a drilling head (104) at its forward end within which is mounted a primary carbide cutting plate (106). The tool has an intermediate helical conveying portion (110) extending between the clamping shank portion (102) and the drilling head (104) around which extend four helical webs (112a-d) and corresponding helical flutes (114a-d). The drilling tool of Figure 7 has a diameter D_1 of 5.8mm.

[0031] The clamping shank of the tool shown in Figure 7 is configured as an SDS-Plus clamping shank, as is well known in the art. The shank comprises a pair of opposing axially closed grooves (116) within which locking elements of a tool holder of a rotary hammer are generally received so as to enable limited reciprocation of the

drilling tool with respect to the tool holder. In addition the shank is formed with two opposing axially extending slots (118) which are open at their rearward ends and which terminate at the rearward end of the shank portion (102). When the drilling tool is fitted within a tool holder of a rotary hammer corresponding splines formed on the tool holder engage in the open slots (18) to transmit rotary drive from the tool holder to the drilling tool.

[0032] The conveying helical portion (110) of the drilling tool comprises four discharge grooves or flutes (14a-d) which extend helically around the drilling tool with a pitch β_1 of 27.3mm. Each of the flutes (14a-d) is bounded on each side by a corresponding helically extending web (12a-d). Two of the webs are formed as primary webs (112b, 122d) have a radially outwardly facing peripheral surface (122) which guide the drilling tool within the drilled hole. The diameter of the primary webs is 5.8mm. Two of the webs are formed as auxiliary webs (112a, 112c) which come to a point at their radially outer ends. The diameter D_2 of the auxiliary webs is 3.8mm or approximately 65% of the diameter of the primary webs (112b, 112d). Each of the primary and auxiliary conveying webs (112a-d) has a conveying surface (20) which faces in the direction of the clamping shank of the tool along which broken material is conveyed. The diameter d_1 of the bases of the flutes (114a-d) is 3.3mm. Each of the pairs of flutes (114a and d) and (114c and b) separated by an auxiliary web (112a, 112c) and the four flutes together extend circumferentially over 74% of the outer circumference (124) of the helical conveying portion of the drilling tool. The radially outer surface (122) of each primary web (112b, 112d) extends over 6.5% of the outer circumference (124) of the helical conveying portion of the frilling tool, which corresponds to a web width α_1 of 1.9mm.

[0033] The drilling head is best understood from Figures 10 to 12 and is formed with a transverse slot within which is fixed, for example by braising the carbide cutting plate (106). The drilling head has a diameter D of 5.8mm. The cutting plate (106) extends axially beyond the forward facing face (108) of the drilling head and radially beyond both ends of the transverse slot in the drilling head to a diameter of 6.285mm.

[0034] The two portions of the drilling head to either side of the cutting plate (106) are each formed with primary axially extending channels (136, 138). The first primary channel (136) extends from the forward facing face (108) of the drill head to the entrance to two of the four flutes (114a, 114d) and the second primary channel (138) extends from the forward facing face of the drill head to the entrance to two of the four flutes (114b, 114c). Each channel (136, 138) extends over 26% of the circumference (128) of the drilling head. This means that both channels together extend over 52% of the circumference of the drilling head, but this percentage may be varied between 34% and 70%. The diameter of the base of each channel is 3.7mm, which is approximately 64% of the diameter of the drilling head, but this percentage may be varied within the range of 40% and 85%. Accordingly, each primary channels (136, 138) is of sufficient volume to efficiently convey broken material from the forward face of the drilling head to the entrances to the other two of the four flutes of the drilling tool. This arrangement, whereby each primary channel (136, 138) conveys broken material into two flutes, greatly improves the conveying of broken material from the forward face of the drilling head to the conveying flutes and significantly reduces the incidence of blockages and improves the ease with which the drilling tool advances into a drilled hole. The channels (136, 138) have radially outwardly facing surfaces which are parallel to the longitudinal axis (X) of the drilling tool. The circumferential positioning of the channels (136, 138) on the drilling head is selected so that each channel, as it extends axially rearwardly intersects two of the flutes (114a-d) and so extends smoothly into two of the flutes (114a-14d). The arrows in Figures 11 and 12 show the transportation of broken material from the primary channel (136) into the flutes (114a) and (114d).

[0035] The auxiliary web (112a) lies between the two flutes (114a and d) into which the channel (136) extends. The auxiliary web (112a) terminates in a circumferentially central portion of the channel (136). Thus, the auxiliary web (112a) provides a broken material conveying surface which communicates with the central portion of the channel (136) so as to convey broken material rearwardly out of the channel. Similarly, the web (112c) separates the flutes (114c and b) into which the channel (138) extends, which web (112c) terminates in a circumferentially central portion of the channel (138). Where there are auxiliary webs it is preferred that these are the webs that terminate in the central portion of the corresponding channel as this provides a larger volume through which broken material can pass between the channels and the associated flutes.

[0036] The cutting plate (106) is of a similar form as but is of smaller size than that described above in relation to the cutting plate (6). In particular the cutting plate (106) is formed with a central chiselling dome (150) and a pair of cutting edges (44) extending radially outwardly from the chiselling dome, with each cutting edge forming a boundary between a cutting face (143) and a trailing relief face (146) of the cutting plate and the acute angle (θ) between the relief face and the longitudinal axis of the tool increases from the radially inner to the radially outer end of each cutting edge

[0037] This design of cutting plate generates high volumes of broken material per unit time and the channels (136, 138) with each cannel feeding broken material into two flutes enables this broken material to be efficiently removed from the region of the cutting plate. Therefore, the performance of the cutting plate (106) is not unduly prejudiced by the presence of broken material.

Claims

1. A masonry or rock drilling tool suitable for use with a rotary hammer comprising:

   a drilling head (4, 104) at a forward end of the tool within which a forwardly extending cutting plate (6, 106) is fitted or formed on the circumferential periphery of which drilling head are formed first and second opposing axially extending channels (36, 38, 136, 138);

   a clamping shank (2, 102) at a rearward end of the tool suitable for fitment within a tool holder of a rotary hammer;

   an intermediate helical conveying portion (10, 110) extending between the drilling head and the clamping shank and comprising at least four helically extending flutes (14a-d, 114a-d) separated by corresponding helically extending webs (12a-d, 112a-d);

   characterised in that the tool additionally comprises the features that:

   the cutting plate is formed with a central chiselling dome (50, 150) and a pair of cutting edges (44, 144) extending radially outwardly from the chiselling dome, wherein each cutting edge has a trailing relief face (46, 146) and the acute angle (θ) between the relief face and the longitudinal axis of the tool varies from the radially inner to the radially outer end of each cutting edge; and

   the first axially extending channel extends axially rearwardly from a forward facing face (108) of the drilling head into a plurality of the at least four flutes and the second axially extending channel extends axially rearwardly from the forward facing face of the drilling head into a different plurality of the at least four flutes.

2. A tool according to claim 1 wherein the acute angle (θ) varies by increasing from the radially inner to the radially outer end of each cutting edge.

3. A tool according to claim 1 wherein the web or webs (12b, 12d, 112a, 112c) that separate the pluralities of flutes each terminate in a location circumferentially central of the associated axially extending channel (36, 38, 136, 138).

4. A tool according to any one of claims 1 to 3 wherein there are four flutes and the first axially extending channel extends into a pair of the four flutes and the second axially extending channel extends into the remaining pair of the four flutes.

5. A tool according to any one of claims 1 to 4 wherein the cutting plate (6, 106) extends transversely across the drilling head (4, 104) and the first channel (36, 136) is formed to a first side of the cutting plate and the second channel (38, 138) is formed to a second opposite side of the cutting plate.

6. A tool according to any one of the previous claims wherein each cutting edge forms a boundary between a respective cutting face (43,143) and a respective trailing relief face (46,146) of the cutting plate.

7. A tool according to claim 6 wherein the acute angle (ϕ) between the cutting face (43, 143) and the longitudinal axis of the tool increases from the radially inner to the radially outer end of each cutting edge (44, 144).

8. A tool according to any one the preceding claims wherein the dome (50, 150) is elliptical with the major axis of the elipse extending substantially parallel to the cutting edges (44, 144).

9. A tool according to any one of the preceding claims wherein the two axially extending channels (36, 38, 136, 138) together extend over between 35% and 70% of the circumferential surface (28, 128) of the drilling head and in particular between 40% and 60% for larger diameter tools.

10. A tool according to any one of the preceding claims wherein the axially extending channels (36, 38, 136, 138) have bases with a diameter of between 40% and 85% of the diameter of the drilling head and in particular between 40% and 60% for larger diameter tools.

11. A tool according to any one of the preceding claims wherein the surfaces of the channels (36, 38, 136, 138) are substantially parallel to the longitudinal axis (X) of the tool.

12. A tool according to any one of the preceding claims wherein the channels (36, 38) are concave.

13. A tool according to any one of the preceding claims wherein auxiliary cutters (30) are fitted or formed at the forward end (8) of the drilling head.

14. A tool according to claim 13 wherein the auxiliary cutters (30) each trail a cutting edge (44) of the cutting plate (6) in the direction of rotation (R).

15. A tool according to claim 14 wherein an additional auxiliary axially extending channel (26) is formed on

the circumferential periphery of the drilling head between each auxiliary cutter (30) and the cutting edge (44) of the cutting plate (6) trailed by said auxiliary cutter and each auxiliary channel extends axially from the forward facing face of the drill head into at least one of the at least four flutes (14a and c).

16. A tool according to any one of the preceding claims wherein the at least four webs (12a-d) have the same diameter.

17. A tool according to claim 16 wherein each of the webs (12a-d) has a radially outwardly facing surface (22) for guiding the drilling tool within a drilled hole.

18. A tool according to any one of claims 1 to 15 wherein the at least four webs include at least two primary webs (112b and d) and at least two auxiliary webs (112a and c) of reduced diameter compared to the primary webs.

19. A tool according to claim 18 wherein the primary webs (112b and d) each have a radially outwardly facing surface (122) for guiding the drilling tool within a drilled hole.

20. A tool according to claim 18 or claim 19 wherein the secondary webs (112a and c) come to a point at their radially outer ends.

21. A tool according to any one of claims 16 to 18 when dependent on claim 3 wherein an auxiliary web (112a, c) separates the flutes into which each axially extending channels (36, 38, 136, 138) extend and the auxiliary web terminates in a circumferentially central portion of the corresponding channel.

22. A tool substantially as hereinbefore described with reference to any one of the accompanying drawings.

23. A masonry or rock drilling tool suitable for use with a rotary hammer comprising:

a drilling head (4) at a forward end of the tool within which a forwardly extending cutting plate (6) is fitted or formed and on the circumferential periphery of which is formed first and second opposing axially extending channels (36, 38);

a clamping shank (2) at a rearward end of the tool suitable for fitment within a tool holder of a rotary hammer;

an intermediate helical conveying portion (10) extending between the drilling head and the clamping shank and comprising at least four helically extending flutes (14a-d) separated by corresponding helically extending webs (12a-d);

characterised in that the first axially extending channel is concave and extends axially rearwardly from a forward facing face (8) of the drilling head into a plurality of the at least four flutes and the second axially extending channel is concave and extends axially rearwardly from the forward facing face of the drilling head into a different plurality of the at least four flutes.

24. A tool according to claim 23 wherein the web or webs that separate the pluralities of flutes each terminate in a location circumferentially central of the associated axially extending channel.

25. A tool according to claim 23 or claim 24 wherein there are four flutes and the first axially extending channel extends into a pair of the four flutes and the second axially extending channel extends into the remaining pair of the four flutes.

26. A tool according to any one of claims 23 to 25 wherein the cutting plate (6) extends transversely across the drilling head (4) and the first channel (36) is formed to a first side of the cutting plate and the second channel (38) is formed to a second opposite side of the cutting plate.

27. A tool according to any one of claims 23 to 26 wherein the cutting plate is formed with a central chiselling dome (50) and a pair of cutting edges (44) extending radially outwardly from the chiselling dome (50), wherein each cutting edge has a trailing relief face (46).

28. A tool according to claim 27 wherein the acute angle (θ) between the relief face (46) and the longitudinal axis of the tool varies, for example by increasing, from the radially inner to the radially outer end of each cutting edge (44).

29. A tool according to either one of claims 27 or 28 wherein each cutting edge forms a boundary between a respective cutting face (43,143) and a respective trailing relief face (46,146) of the cutting plate.

30. A tool according to claim 29 wherein the acute angle (ϕ) between the cutting face (43) and the longitudinal axis of the tool varies, for example by increasing from the radially inner to the radially outer end of each cutting edge (44).

31. A tool according to any one of claims 27 to 30

wherein the dome (10) is elliptical with the major axis of the elipse extending substantially parallel to the cutting edges (44).

32. A tool according to any one of claims 23 to 31 wherein the two axially extending channels (36, 38, 136, 138) together extend over between 35% and 70% of the circumferential surface (28, 128) of the drilling head and in particular between 40% and 60% for larger diameter tools.

33. A tool according to any one of claims 23 to 32 wherein the axially extending channels (36, 38, 136, 138) have bases with a diameter of between 40% and 85% of the diameter of the drilling head and in particular between 40% and 60% for larger diameter tools.

34. A tool according to any one of claims 23 to 33 wherein the surfaces of the channels (36, 38, 136, 138) are substantially parallel to the longitudinal axis (X) of the tool.

35. A tool according to any one of claims 23 to 34 wherein auxiliary cutters (30) are fitted or formed at the forward end (8) of the drilling head.

36. A tool according to claim 35 wherein the auxiliary cutters (30) each trail a cutting edge (44) of the cutting plate (6) in the direction of rotation (R).

37. A tool according to claim 36 wherein an additional auxiliary axially extending channel (26) is formed on the circumferential periphery of the drilling head between each auxiliary cutter (30) and the cutting edge (44) of the cutting plate (6) trailed by said auxiliary cutter and each auxiliary channel extends axially from the forward facing face of the drill head into at least one of the at least four flutes (14a and c).

38. A tool according to any one of claims 23 to 37 wherein the at least four webs (12a-d) have the same diameter.

39. A tool according to claim 38 wherein each of the webs (12a-d) has a radially outwardly facing surface (22) for guiding the drilling tool within a drilled hole.

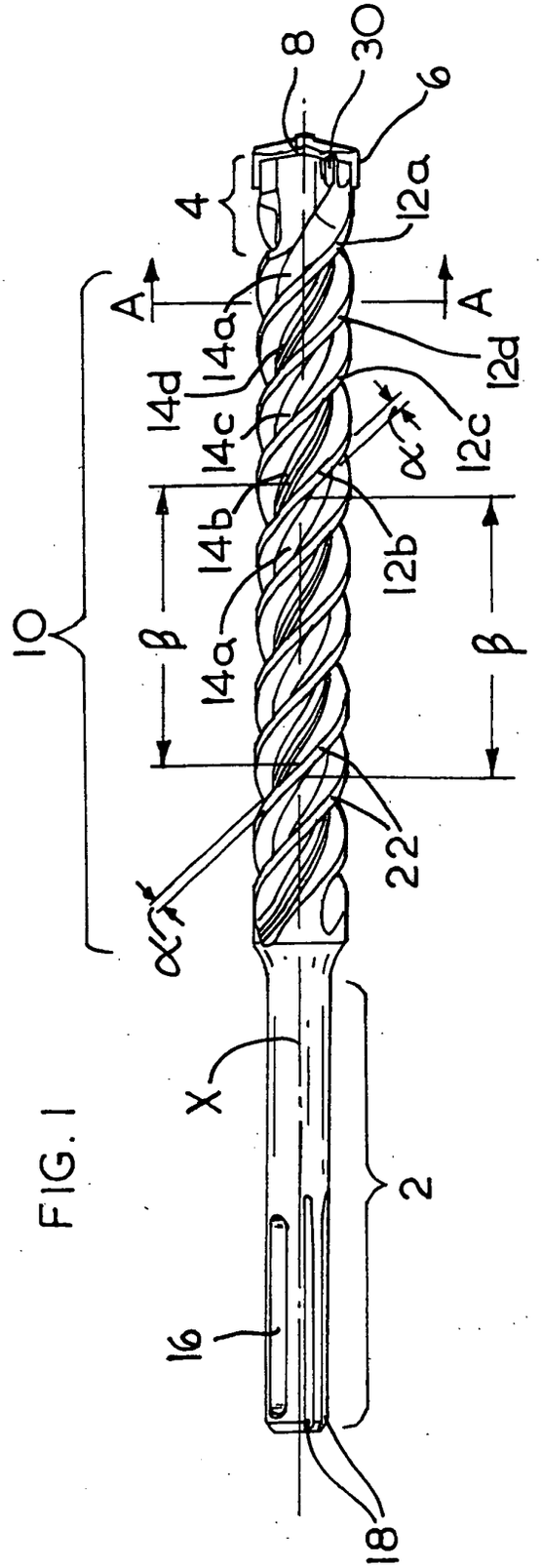

FIG. 1

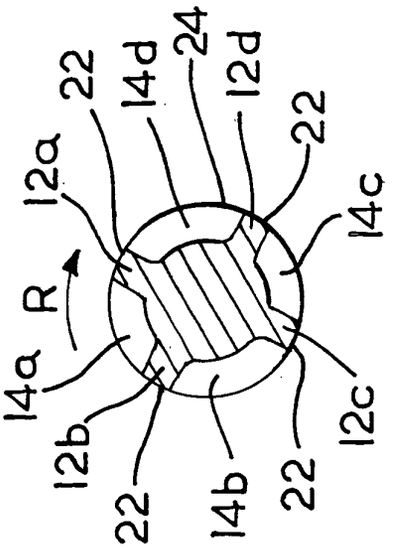

FIG. 3

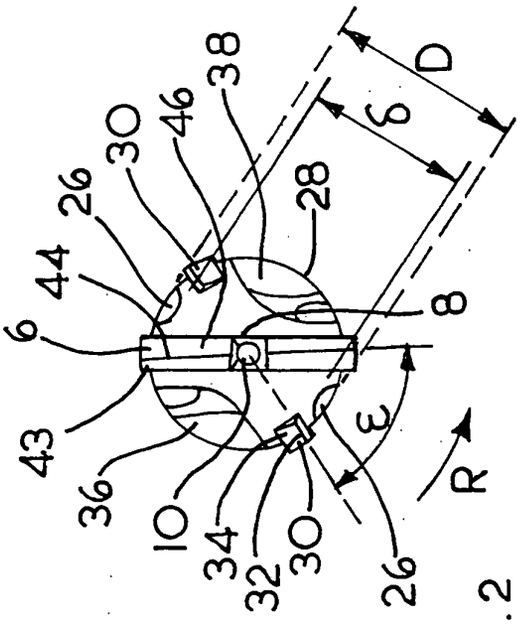

FIG. 2

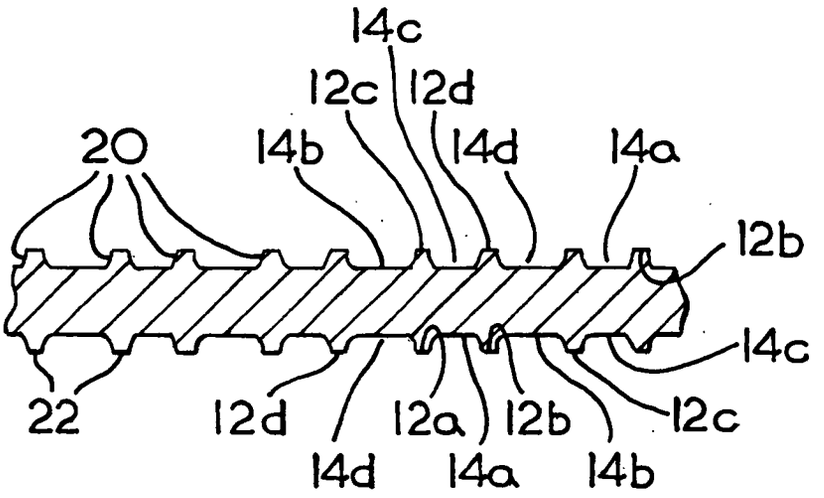

FIG. 4

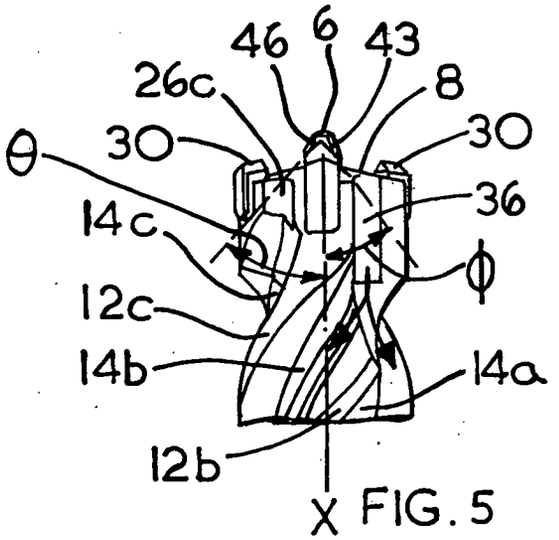

FIG. 5

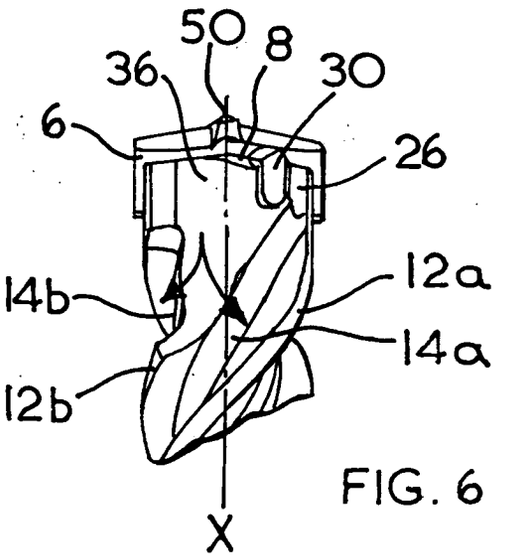

FIG. 6

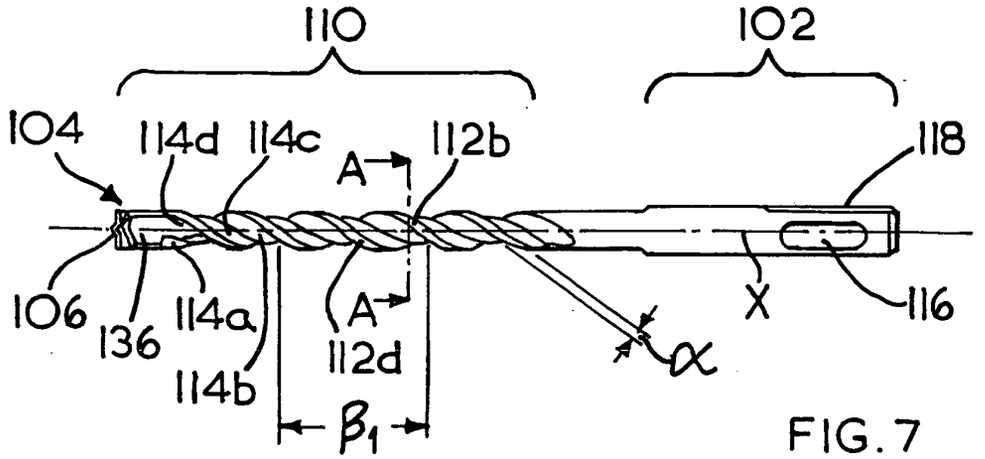

FIG. 7

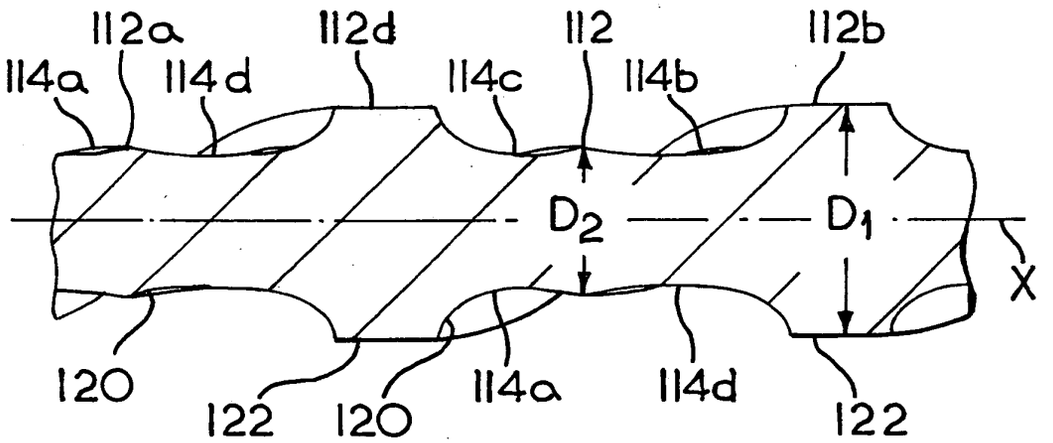

FIG. 8

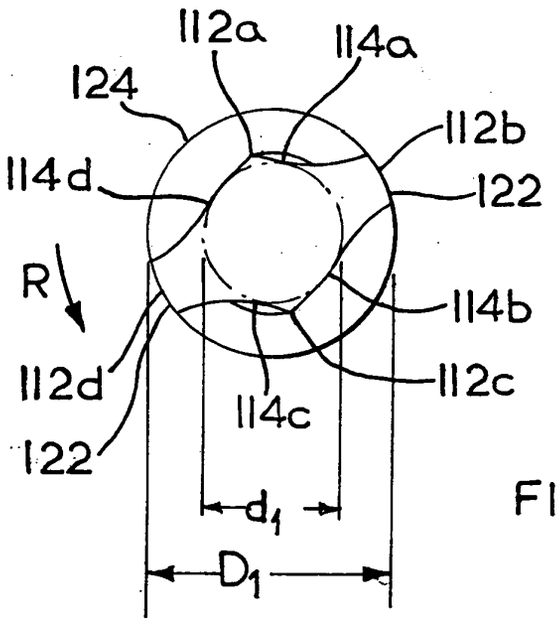

FIG. 9

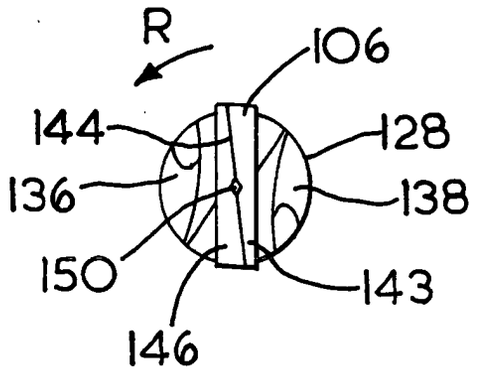

FIG. 10

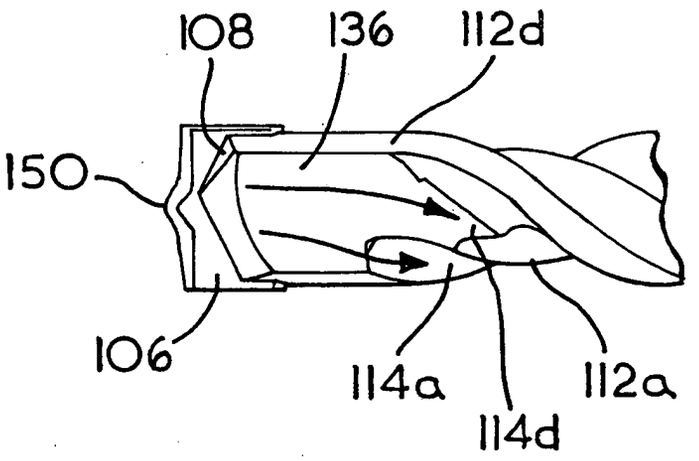

FIG. 11

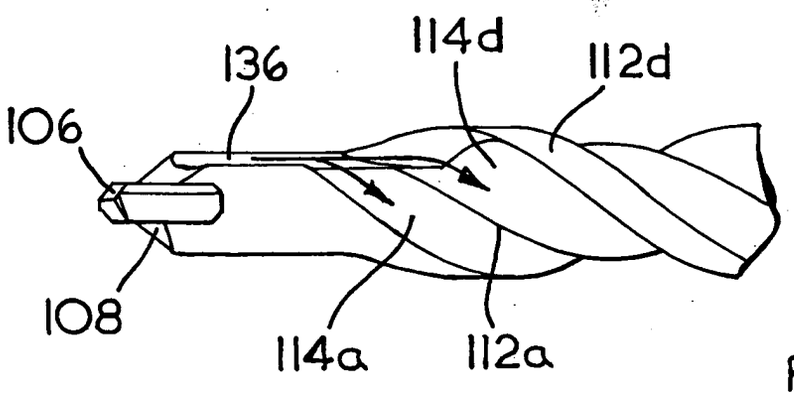

FIG. 12

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 03 02 0167

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
A	US 6 116 361 A (W. KLEINE ET AL.) 12 September 2000 (2000-09-12) * the whole document * ---	1,3,5, 9-12,17, 19,23, 26, 32-34,39	E21B10/44 B23B51/00
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TECHNICAL FIELDS SEARCHED (Int.Cl.7)

E21B
B23B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
MUNICH	26 November 2003	Fanti, P

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